



## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

This invention relates to a method of automatically performing the calculations usually performed by the printer operator in laying out a print job so as to optimize the location of the printed image on the paper media, for example minimizing the amount of trimming required after printing on media larger than the desired final size. More particularly, the invention relates to automatically laying out the image size and location on the page so that, even in duplex printing, the amount of post-printing handling, such as trimming, is minimized.

### 2. Brief Description of the Related Art

The invention relates to apparatus and methods for production of printed images on paper media. For the sake of clarity, the four edges of such paper media may be referred to herein as the leading edge, the trailing edge and two lateral edges, in reference to the direction of travel through the printer. The printed output is referred to in terms of a print area, defined by a length and width of the finished printed product, after post-printing trimming.

Many digital printers and copiers are capable of producing a finished product having the appearance of documents produced using ink-based, offset printing techniques. Such output includes brochures and the like, where the customer desires that the entire page be printed, with no unprinted margins or edges. One option for producing such documents is to print on oversize media and trim the four unprinted edges off the printed output to yield the finished product. This method produces an acceptable product and, indeed, may be requested by some customers. However, it introduces an additional production step, requiring an operator to setup a post-printing trimming device and trim the printed output to desired dimensions of the final product. In addition to increasing labor costs and production time, the additional operator intervention required introduces the possibility of operator error, resulting in expensive wasted print runs.

In setting up a print job that will be trimmed after printing, the operator is required to calculate a layout that will center the image, resulting in the same margin on

the leading edge and trailing edge, on both the front and back sides of the page, followed by trimming to remove the portion outside the margin on both edges. Additional problems arise when the operator is required to print on odd-size media, for example 7" by 9" rather than 8½" by 11" media. This situation is especially problematic when the job must be printed on larger media than the customer wants delivered as the finished product. In this situation, the operator is required to perform sophisticated layout work, manually calculating the image shift required to place the image in the appropriate position on the media. In the case of simplex (single-sided) copying, the operator is required to shift the image only past any enforced printer margin, for example, a 1/10" enforced margin on the leading edge of the page, followed by appropriate trimming on all four edges to yield that finished product. In duplex (two-sided) printing, however, the image must be shifted so that the image on the first side of the page and the image on the second side of the page coincide in the same area, so that none of the image on either side is lost in trimming. For example, in the case of printing a 7" x 9" image on 8.5" x 11" paper, the calculations would involve shifting the image from each edge, *i.e.*, by shifting the *x*-origin by  $(8.5 - 7)/2$  inches and the *y*-origin by  $(11 - 9)/2$  inches. The printed output must then be trimmed to remove the portion of the paper outside these shift values. Therefore, the calculations involved in such layout work must be preserved, written down and sent to the person performing the trimming, along with the finished printing output. The trimming operator must then replicate the calculations exactly in setting up the trimming device, or the finished copy output will be trimmed incorrectly, ruining the entire print job. Each of the steps in the layout process and the setup operations on the trimming device are time-consuming, labor-intensive and are potential sources of operator error.

Many high-end printers and copiers can be enabled to print "full bleed," that is, they may be setup to print to the very edge of the paper medium. However, because of quality concerns, many electrophotographic marking engines do not allow full bleed printing on all four edges of the medium. These quality concerns relate mainly to the retention of toner on the leading edge of the media. Prior to fusing, the toner is held in association with the paper by electrostatic forces. However, the toner does not bind as well at the edges of the media, particularly because it is more susceptible to being shaken

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off the paper when the leading edge is contacted by the fuser nip rollers and, therefore when the leading edge enters the fuser nip rollers, the leading edge of the page is particularly susceptible to smearing or other problems resulting in poor print quality. Therefore, in order to avoid such problems, many printers only allow full-bleed printing on the trailing and lateral edges, with an enforced printer margin on the leading edge. However, in duplex printing, the leading edge of the first side of the page does not coincide with the leading edge of the second or reverse side of the page. In fact, the leading edge of the first side of the page becomes the trailing edge of the second side of the page. This makes it impossible to simply print to the limit of the enforced margin on the leading edge on both sides and trim the finished product, as the trimming will remove a portion of the image on each side of the page.

By taking advantage of the ability of such printers to print to the very edge of the page, it is possible to locate the print area on the page such that post-printing trimming is minimized. In some instances, this may require no more than centering the image between the leading and trailing edges with full-bleed printing on the lateral edges, necessitating trimming of only two sides. Such an approach is equally useful in single-sided and double-sided printing. Alternatively, in single-sided printing, it may be possible to print full-bleed on the trailing and lateral edges, trimming only the leading edge.

Additionally, one may use the different size media available, selecting the media on which the print area fits optimally. By taking advantage of the ability of the printer to print full bleed, in conjunction with the ability to shift and rotate the image, it is possible to optimize the location of the image on the page. As used herein, optimizing the location of the image on the page includes minimizing post-printing trimming, as well as other beneficial results of the invention, such as allowing processing of print jobs on available media by manipulating the location of the image on the page.

Therefore, in view of these disadvantages of the prior art and current practices there is a need in the art for a printer that takes advantage of the full-bleed printing capability of current printers and automatically performs the necessary layout calculations. Therefore, it is an object of the present invention to take advantage of the

ability of such printers to print to the very edge of the page, locating the print area on the page such that post-printing trimming is minimized.

It is an additional object of the invention to use the different size media available, selecting the media on which the print area its optimally, for example by rotating the print area if necessary and locating the print area so as to minimize post-printing trimming.

These and other objects and advantages of the invention are illustrated and clarified by the following detailed description of preferred embodiments of the invention, with appropriate reference to the figures described below.

## SUMMARY OF THE INVENTION

In a preferred embodiment, the invention is a method of automatically laying out a print job for printing on a printer having a plurality of available media sizes, wherein the print job includes a designated print area, defined by the designated length and width of the finished printed output, the method including the steps of setting up the print job, where the print job includes data to designate the length and width of the finished printed output, determining whether the print area is smaller than an available media size and enabling the printer to print full-bleed. Then the system determines whether the print area must be rotated to fit the print area on an available media size and automatically calculates the distance and direction in which the print area must be shifted to locate the print area on the media in such a manner as to minimize post-printing trimming. Finally, the print job is printed with the calculated image area shift and image area rotation.

In one embodiment of the invention, the method is used to layout a single-sided print job, while in another embodiment, the method is used to layout a double-sided print job. Additionally, in yet another embodiment, the method includes the additional step of printing an instruction sheet accompanying the print job that lists instructions for setting up a post-printing trimming device to perform the necessary trimming operations.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic representation of the architecture of a print system employing the present invention.

FIG. 2 is a flow diagram representing the function of the software utilized with the present invention for simplex printing.

FIG. 3 is a flow diagram representing the function of the software utilized with the present invention for duplex printing.

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## **DETAILED DESCRIPTION OF THE DRAWINGS AND PREFERRED EMBODIMENTS**

Referring to Fig. 1, a typical print system 10 of the type employing the present invention includes a printer 20 having a user interface 21 and network interface 22  
10 connecting the printer 20 to a network 28. While the exemplary print system 10 shown is a network printing system intended to receive remote input through a network connection, other configurations are contemplated and possible within the scope of the present invention. For example, the printing system could be a stand alone printer, including a scanner for on-site image input. Additionally, the printer could be connected  
15 to a scan workstation, with the calculated layout displayed for operator approval upstream of the printer. While a particular printer configuration is discussed herein, it is to be understood that the present invention may be incorporated in other printing system configurations.

The printer 20 includes a raster image processor 26 that receives incoming data  
20 from the network 28. The raster image processor 26 includes processing unit 30, that receives control commands and data from the network 28. Control commands are translated into machine control language by the processing unit 30, while incoming print jobs and program codes are stored in a print job buffer 32.

The printer 20 also includes a marking engine 40, that incorporates a plurality of  
25 available media supplies, and other standard paper handling and processing equipment necessary, for example, for producing printed images on output paper. The marking engine 40 receives and stores in a multiple page image buffer 23, a data stream, including image data and control data generated by the processing unit 30. The image data is processed and transmitted to a print head 42 for transfer to the output pages. In a  
30 preferred embodiment, the print head is equipped with a plurality of light emitting diodes 44 (LEDs) that act as the print head light source. When a print job is sent to the marking

engine 40, control commands issuing from the raster image processor 26 specify a subset of the LEDs 44 that emit light. By disabling LEDs 44 outside a certain limit, the print head control commands delineate the outer boundaries and parameters of the printed image.

5           The operation of the present invention is illustrated by the flow diagrams depicted in Figs. 2 and 3. When a print job is submitted to the printer 20 through the network 28, the print job submitter enters information specifying a number of characteristics of the print job, including the desired size of the final printer output after printing and trimming, for example 8.5" x 11" or 7" x 9". Additionally, the submitter enters data indicating  
10 whether the print job is to be simplex, *i.e.*, single-sided, or duplex, *i.e.*, double-sided. If the print job submitter selects a simplex print job, the software illustrated by the flow diagram of Fig. 2 is enabled. Alternatively, if the print job submitter selects a duplex print job, the software illustrated by the flow diagram of Fig. 3 is enabled. These alternatives are discussed in turn below and, in the following discussion, the term "Xf" denotes the desired width of the final, output paper and, likewise, "Yf" denotes the  
15 desired length of the final, output paper. Together Xf and Yf define an image area to be printed on the selected media.

Referring to Fig. 2, when the print job submitter has selected simplex printing, the method of operation of the present invention includes determining in Step 100 whether  
20 the customer has requested that all four edges of the paper be trimmed. If an affirmative response is received to Step 100, Step 102 compares the Xf and Yf dimensions to the paper available in the printer, and determines whether the area defined by Xf and Yf will fit on available media including twice the printer margin, in order to optimize the location of the image area on the media. If an affirmative response is received to Step 102, Step  
25 103 is an inquiry to determine whether the attributes of the media other than size match the media attributes entered when the print job was setup. If an affirmative response is received to Step 103, Step 105 displays the selected media and waits until the operator enters a response before proceeding. If the operator enters a negative response to Step 105, Steps 102, 103 and 105 are repeated until the operator enters an affirmative response  
30 to Step 105, whereupon, in Step 104, the image is printed on the selected media, using the appropriate image shift and, if necessary, the appropriate image rotation value. In

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attributes of the media other than size match the media attributes entered when the print job was setup. If an affirmative response is received to Step 117, Step 119 displays the selected media and waits until the operator enters a response before proceeding. If the operator enters a negative response to Step 117, Steps 116, 117 and 119 are repeated until the operator enters an affirmative response to Step 119, whereupon, Step 118 enables the printer to print "full bleed," *i.e.*, off the edge of the page. Step 120 rotates the image 90° and prints the image with the appropriate X,Y shift. Step 122 then displays on the printer user interface 21 a message specifying the trim directions for the one edge of the page that requires trimming. In a preferred embodiment, the trim instructions are printed on a trailer page as an instruction sheet that can accompany the finished print job to the off-line trimmer. The operator of the trimming device may refer to the instruction sheet when setting up the trimming device. In Step 123, the print job is allowed to continue to completion.

If the response to Step 116 is negative, Step 124 is an inquiry to determine whether Xf,Yf fits on available media, allowing for the printer margin. If the response to Step 124 is affirmative, Step 125 is an inquiry to determine whether the attributes of the media other than size match the media attributes entered when the print job was setup. If an affirmative response is received to Step 125, Step 127 displays the selected media and waits until the operator enters a response before proceeding. If the operator enters a negative response to Step 127, Steps 124, 125 and 127 are repeated until the operator enters an affirmative response to Step 127, whereupon, Step 126 prints on the selected media with the appropriate X,Y shift and, if necessary, the appropriate image rotation value. In Step 128, a message is displayed on the printer user interface 21 with the instructions for trimming on the four sides of the paper. The trim instructions are generated by the raster image processor, and include the distance and direction in which the image was shifted. In a preferred embodiment, the trim instructions are printed on a trailer page as an instruction sheet that can accompany the finished print job to the off-line trimmer. The operator of the trimming device may refer to the instruction sheet when setting up the trimming device. In Step 129, the print job is allowed to continue to completion.

If a negative response is received to Step 124, in Step 130 a message is displayed on the printer user interface to the effect that the "Request is too large for available media."

If the print job submitter selects duplex printing, the software illustrated by Fig. 3 is enabled. Referring to Fig. 3, Step 200 is an inquiry to determine whether the print job submitter has required that four trim cuts be made. If the response to Step 200 is affirmative, Step 220 is an inquiry to determine whether the area defined by  $X_f$  and  $Y_f$  fits in available media, allowing for the printer margin. If the response to Step 220 is negative, Step 230 displays a message on the printer user interface to the effect that "Request is too large for available media."

If the response to Step 220 is affirmative, Step 221 is an inquiry to determine whether the attributes of the media other than size match the media attributes entered when the print job was setup. If an affirmative response is received to Step 221, Step 223 displays the selected media and waits until the operator enters a response before proceeding. If the operator enters a negative response to Step 221, Steps 220, 221 and 223 are repeated until the operator enters an affirmative response to Step 223, whereupon Step 222 prints the image on the media with the appropriate  $X, Y$  shift and, if necessary, the appropriate image rotation value. In Step 224, a message is displayed on the printer user interface 21 with the instructions for trimming on the four sides of the paper. The trim instructions are generated by the raster image processor, and include the distance and direction in which the image was shifted. In a preferred embodiment, the trim instructions are printed on a trailer page as an instruction sheet that can accompany the finished print job to the off-line trimmer. The operator of the trimming device may refer to the instruction sheet when setting up the trimming device. In Step 225, the print job is allowed to continue to completion.

If the response to Step 200 is negative, Step 202 is an inquiry to determine whether the cross-track dimension of any available media matches  $X_f$  and whether  $Y_f$  is smaller than the leading edge of the paper by at least twice the printer margin. If the response to Step 202 is affirmative, Step 203 is an inquiry to determine whether the attributes of the media other than size match the media attributes entered when the print job was setup. If an affirmative response is received to Step 203, Step 205 displays the

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margin. If the response to Step 220 is negative, Step 230 displays a message on the printer user interface to the effect that "Request is too large for available media."

If the response to Step 220 is affirmative, Step 221 is an inquiry to determine whether the attributes of the media other than size match the media attributes entered when the print job was setup. If an affirmative response is received to Step 221, Step 223 displays the selected media and waits until the operator enters a response before proceeding. If the operator enters a negative response to Step 221, Steps 220, 221 and 223 are repeated until the operator enters an affirmative response to Step 223, whereupon Step 222 prints the image on the selected media with the appropriate X,Y shift and, if necessary, the appropriate image rotation value. In Step 224, a message is displayed on the printer user interface 21 with the instructions for trimming on the four sides of the paper. The trim instructions are generated by the raster image processor, and include the distance and direction in which the image was shifted. In a preferred embodiment, the trim instructions are printed on a trailer page as an instruction sheet that can accompany the finished print job to the off-line trimmer. The operator of the trimming device may refer to the instruction sheet when setting up the trimming device. Step 225 allows the print job to continue to completion.

The operation of the present invention may also be illustrated by an example, in which the customer desires a 7"x9" final printed output, *i.e.*,  $X_f=7"$  and  $Y_f=9"$ , with no unprinted margins. The media available include 8.5" x 11" paper in white and blue, 11" x 14" in white and 11" x 17" in white and blue. The operator inputs certain characteristics about the print job, including selecting blue duplex output, 7" x 9" original size and fully automatic operation.

The operator enters a negative response to Step 200, and deselects "mandatory 4 trim cuts." Step 202 then compares  $X_f$  to the cross track dimensions of the available media, determining that  $X_f=9$  does not match the cross track dimension of any available media. Step 210 then compares  $Y_f$  to the cross track dimensions of the available media, and determines that  $Y_f=7$  does not match the cross track dimension of any available media. Step 210 then compares the  $X_f, Y_f$  area to the available media, determines that the best fit is on 8.5" x 11" media, with the image printed using a 90° rotation and a shift 0.75" toward the center of the page from the trailing edge and 1" toward the center of the

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page from the lateral edges, and selects 8.5" x 11" white paper. Step 211 compares the attributes of the media other than size to the media attributes entered when the print job was setup, in this case determining that the "color" attribute of the automatically selected paper, *i.e.*, white, does not match the operator-input color attribute, *i.e.*, blue. Therefore, Step 210 is repeated, selecting the same size media, with the same shift and rotation, but in blue. Step 213 then displays the selected media and waits until the operator enters a response before proceeding. The operator reviews the selected media and enters an affirmative response to Step 213, whereupon Step 212 prints the image on the selected media with the appropriate X,Y shift and the appropriate image rotation value. In Step 214, a message is displayed on the printer user interface 21 with the instructions for trimming on the four sides of the paper and the trim instructions are printed on a trailer page as an instruction sheet that can accompany the finished print job to the off-line trimmer. In another preferred embodiment, when an in-line automatic trimmer is attached to the printer, the trim instructions may be sent directly to the trimmer, to allow trimming to be performed automatically. Step ~~215~~ allows the print job to continue to completion.

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In operation, the image shift and rotation are accomplished by conventional methods well-known to those of ordinary skill in the pertinent art, for example by manipulating the raster image data. For example, in a preferred embodiment, the method is employed on a conventional copier of the type employing an endless rotating film belt from which the images are reproduced on the paper media by initiating a flash lamp to affix the toner to the paper. By varying the timing of flash with respect to the revolutions of the film belt, the image may be placed closer to or further from the leading edge of the paper media.

Additionally, the invention may be employed on a printer using a write head having a plurality of LEDs 44 that are activated to print the image on the paper. In such a configuration, the location of the image may be shifted by varying which of the LEDs 44 on the write head are activated by the write head command codes. The location of the print area on the paper media may be shifted by activating a block of LEDs 44 closer to or further away from the leading edge and/or or lateral edge of the paper media.

Finally, the image shift and rotation may be accomplished by using a print software program, such as PostScript, that directs the marking engine to build in the appropriate image shift and rotation. Such programs typically build in an image offset relative to a reference point, such on of the corners of the image area, for example.

- 5        It is to be understood that the foregoing detailed description describes presently preferred embodiments of the invention and that other alternatives, which will become apparent to those of skill in the art upon reviewing the foregoing description, are likewise intended to fall within the scope of the appended claims, including equivalents thereto.

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